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Vocalic [e] Epenthesis and Variation in Farsi-English Interlanguage Speech

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Abstract

This study investigates the variable production of English /s/ + consonant onset clusters in the speech of 30 adult native Farsi speakers learning English as a second language (L2). In particular, the study examines the development of the homorganic /st/, /sn/ and /sl/ sequences (sC clusters), which are realized variably either via e-epenthesis (e.g., [est]op) or via its target L2 pronunciation (e.g., [st]op). The sentence reading task as well as the picture-based interview utilized in this investigation followed sociolinguistic procedures for data collection and analyses, and included a set of linguistic (e.g., preceding phonological environment, sonority profile of the cluster) and extra-linguistic factors (e.g., level of formality, proficiency in English) whose effects were measured statistically via GoldVarb X. The results reveal that: (1) the proportion of [e]-epenthesis is higher after a word-final consonant or pause than after a vowel (in which case the sC cluster is resyllabified as two separate syllables, i.e. [Vs.CV]); (2) over time (hence with increased L2 proficiency) and in formal situations, the amount of epenthesis decreases, conforming with Major's (2001) Ontogeny Phylogeny Model; and (3) as observed in several studies of L1 acquisition, markedness on *continuancy* – rather than markedness on sonority – is better able to capture the variable patterns of e-epenthesis in the Farsi-English interlanguage data (i.e., the more marked structures /st/ and /sn/, in which the continuancy feature varies (from [+continuant] /s/ to [-continuant]

/t/ and /n/) are more likely to trigger the phenomenon of [e]-epenthesis than the less marked nonnative cluster /sl/, in which continuancy is maintained constant (from [+continuant] /s/ to [+continuant] /l/).

It has long been established that interlanguage (IL), the learner's developing second language, is a system characterized by variability (e.g., Bebee & Zuengler, 1983; Dickerson, 1975; Ellis, 1994; Major, 2001; Preston, 1996; Tarone, 1979). This variability has often been approached from two different perspectives: the variable rules approach (e.g., Bayley & Preston, 1996; Labov, 1969), whereby the degree to which contextual factors contribute to the applicability of a rule is identified; and the Dynamic Paradigm (Bickerton, 1973; Gatbonton, 1978), whereby variation in second language (L2) acquisition is seen as a systematic but unstable phenomenon mediating through the gradual 'diffusion' of target-like forms into learners' developing grammars. Irrespective of the approach adopted, however, it is usually agreed that IL variability manifests itself through an alternation of target-like and nontarget-like forms.

In L2 phonology, for example, many English as a Second or Foreign Language (ESL) learners whose native language (L1) prohibits /s/ + consonant clusters (sC henceforth) – e.g., Spanish, Portuguese, Japanese, and most varieties of Arabic – tend to cope with these clusters by inserting an epenthetic vowel before the sC sequence (e.g., /e/ in the case of Iraqi Arabic, and /i/ in the case of Brazilian Portuguese). Farsi learners of ESL are no exception to this general pattern: When these learners are faced with the illicit sC onset sequences, they too have a tendency to apply e-epenthesis (e.g., Karimi, 1987; Yarmohammadi, 1995). This application of e-epenthesis, however, is not categorical as the discussion above suggests. Rather, it is a variable process in which the problematic sC clusters are realized *variably* either via e-epenthesis (e.g., [**esn**]ail) or via its target L2 pronunciation (e.g., [**sn**]ail).

In many ways, the present study is inspired by recent L2 phonological research which has looked into the acquisition of L2 syllables from an integrative approach that incorporates sociolinguistic methodology for data collection and analysis, and current advances in phonological theory (e.g., Cardoso, 2005, 2007, 2008; Escartin, 2005; John, 2006). Escartin's (2005) study, for instance, examined the variable acquisition of all instances of sC onset clusters – /sn/, /sl/, /st/, /sm/, /sp/, and /sk/ – by Mexican Spanish speakers learning ESL. The current study, however, is limited in its scope to investigate the variable development of the homorganic /st/, /sn/ and /sl/ onset clusters – which all share the coronal articulator – in the English IL speech of Farsi speakers.

By including only a set of homorganic onset clusters, the present study attempts to avoid a possible confounding influence of *place of articulation* on L2 production. Prior studies on L2 syllable patterns have in general overlooked the potential effects that place of articulation can have on the development of nonnative sC clusters, although few of these studies did suggest a link between heterorganicity (i.e., a difference in place of articulation) and difficulty of sC cluster production (e.g., Carlisle, 2006; Greenberg, 1965). Because this so called link has not yet been the object of empirical investigation, the study we propose here provides an opportunity to address this oversight. In sum, to put aside a difference in place of articulation confound, the current investigation will incorporate only the homorganic sets /st/, /sn/ and /sl/.

In addition to its attempt to control for place of articulation effects, the current study also seeks to extrapolate previous knowledge on L2 acquisition of sC onset clusters to a new research population, namely *Farsi* native speakers learning ESL. Whereas previous research on L2 phonology has examined the pronunciation of sC clusters from a variety of native language backgrounds (e.g., Spanish, Portuguese), it has nonetheless ignored the investigation of these clusters from an L1 Farsi perspective. An investigation of the phenomenon from the L1 Farsi perspective may potentially extend our understanding regarding the acquisition of sC sequences in general. By the same token, the incorporation of Farsi as a source language (and English as a target language) will allow us to obtain valuable information on IL development for comparison with a wide range of other IL data; in particular, data involving native populations with a similar syllable onset structure as Farsi (e.g., Spanish, Portuguese, and Japanese).

Another important feature of the current study, aside from its focus on homorganicity and Farsi native population, concerns the methodological framework used. In particular, the study adopts a variationist methodology to account for variability in L2 acquisition: It takes into account *both* linguistic factors such as preceding phonological environment (i.e., consonant, vowel, and pause), markedness involving sonority, *and* extra-linguistic factors such as proficiency and level of formality; it also employs knowledge from current research in phonological theory. By including a set of internal and external variable constraints and examining how they individually and interactively influence L2 development, the present investigation hopes to provide a more 'realistic' and comprehensive view of the phenomenon under study (i.e., e-epenthesis).

In sum, the intended contributions of the current study to L2 research are believed to be the following: (1) It focuses on the *homorganic* /sn/, /sl/, and /st/ onset clusters in order to avoid the effect of different places of articulation within the clusters; (2) it extends findings of previous research on the acquisition of L2 sC onsets (e.g., those involving Spanish and Portuguese speakers) to a new research population, namely, Farsi native speakers; and (3) it utilizes a sociolinguistic methodology for data collection and analysis (where an assortment of linguistic and extra-linguistic factors are examined), as well as insights from contemporary phonological theory to analyze variation in learner speech.

For this study, a semi-experimental, cross-sectional design was used in which speech samples from 30 adult native Farsi speakers categorized across three levels of proficiency in English (i.e. beginner, intermediate, and advanced) were recorded. The recorded samples consisted of sentence reading tasks as well as picture-based interviews and, in accordance with the standard conventions of sociolinguistic research, included a set of internal and external variable constraints whose effects were measured statistically via GoldVarb X (Sankoff, Tagliamonte, & Smith, 2005).

These are the general research questions that we address in this study:

(a) Is variability in the L2 speech of learners systematic? (b) If so, what is the source of the systematicity? (c) What are, in particular, the linguistic and extra-linguistic factors that condition the *variable* production of sC in the IL speech of Farsi speakers? (d) How does the variation observed in IL compare to that related to the so-called 'fully-developed' languages?

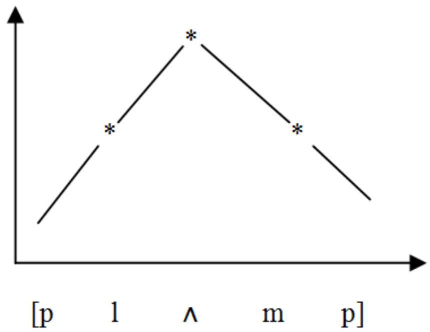
The paper proceeds as follows: In the following section, we provide a background discussion of the theory underlying our study, focusing in particular on the relationship between *sonority markedness* and the developmental path anticipated for the sC sequences in our study. Also discussed in this section is a comparative account of the sC syllable in Farsi and English, as well as a brief survey of research on the effects of linguistic and extra-linguistic factors on the development of IL. We then present the research design of the study, which is characterized by the use of sociolinguistic protocols for data collection and analysis. This is followed by the discussion of the results from the multivariate (Goldvarb X) analyses, which suggest that the development of e-epenthesis in the IL speech of Farsi speakers is conditioned by internal factors such as *preceding phonological environment*, *type of sC cluster* (sonority), and external factors such as *proficiency* and *style*. Finally, the last section is dedicated to our concluding remarks for the study.

THEORETICAL BACKGROUND

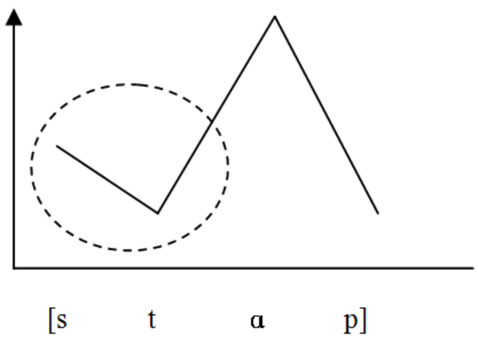
Markedness on Sonority & sC Cluster Development

In order to better understand the relative markedness of the sC clusters investigated in our study (/st/, /sl/, and /sn/), we appeal to two widely used, syllable-related generalizations: the Sonority Sequencing Principle (e.g., Clements, 1990; Selkirk, 1984; Steriade, 1982) and the Minimal Sonority Distance (e.g., Broselow & Finer, 1991; Clements, 1990; Harris, 1983). Prior to that, however, a definition of the notion of sonority is in order. The sonority of a segment is primarily determined by the degree of opening of the vocal tract during its production (e.g., Goldsmith, 1990; Jespersen, 1922; Wright, 2004, Yavas, 2006). That is, the more open the vocal tract is for a sound, the higher its sonority will be. Secondarily, this sonority may also be defined in terms of the propensity of a sound for voicing (e.g., Kenstowicz, 1994; Ladefoged, 1993; Vennemann, 1988; Yavas, 2006). That is, voiced sounds are more sonorous than their voiceless counterparts. Accordingly, the Sonority Sequencing Principle (SSP) is defined as a universal tendency whereby onsets exhibit a sonority rise from peripheral segments towards the nucleus. That is, preferred syllables typically display a continuous rise in sonority towards the peak and a decrease in sonority towards the edges, as is illustrated by the syllable structure of the English word 'plump' in (1). On the other hand, dispreferred syllables such as the /st/ sequence in the English word '[st]op' in (2), exhibit a sonority decrease (reversal) from the first member /s/ to the second member /t/ of the onset, as indicated by the dotted circle in (2).

(1) Syllable structure: Sonority Sequencing



(2) Syllable structure: Sonority violation



Let us now examine the markedness relationships among the sC sequences included in our study (/st/, /sl/, /sn/), especially with regard to the Sonority Sequencing Principle (SSP) outlined above. Because the onset sequence /st/ violates the SSP (see (2) above), this structure is assumed to be the most marked and therefore the most difficult to acquire (Eckman, 1977). This leads us to predict that the /st /structure will surface later in the IL speech of Farsi speakers, as illustrated in (3), where '>' means 'easier than and thus acquired before.'

(3) Markedness hierarchy between SSP-following and SSP-violating sC sequences: /sl/, /sn/ > /st/

In addition to the markedness relationship between SSP-violating versus SSP-abiding sC clusters, a markedness hierarchy also exists between the two sequences that follow the SSP, namely, /sn/ and /sl/. To account for this type of hierarchy, we shall invoke another well-known principle of sonority markedness, as mentioned earlier: the Minimal Sonority Distance (MSD). The core idea behind the principle of MSD is that onset sequences across a large variety of languages exhibit a tendency whereby the second segment has *higher* sonority than the first segment. That is, cross-linguistically, onset clusters prefer to maximize the sonority distance between their member segments. Based on this generalization, it follows that /sl/ is more universally preferred, and thus less marked, than /sn/ (the sonority distance between the segments in the former structure - /sl/- being relatively higher). That /sl/ is more universally preferred than /sn/ reflects a well-established view in linguistics: Syllables across many languages prefer CV structure, and the wide sonority distance between /s/ and /l/ closely resembles that structure (e.g., Cardoso, 2008; Clements, 1990).

Another justification for the relevance of the MSD principle to account for sC cluster markedness can be traced to L1 acquisition. When children attempt to produce the target sC clusters, they usually modify them by deleting one member in the sequence, often the most sonorous segment (e.g., /stil/ 'still'→ [til]), and /slim/ 'slim'→ [sim]). In other words, the reduction patterns observed in children are determined by sonority factors (e.g., Gnanadesikan, 2004; Goad & Rose, 2004; Ohala, 1999, Pater & Barlow, 2003).

In sum, the account regarding the markedness relationship between /sl/ and /sn/ (which is derived from the MSD principle discussed above) allows us to predict that /sl/ will develop earlier in the IL of the Farsi learners, as illustrated in (4) below. Combining this MSD-based account (i.e., (4)) with the SSP-related perspective (see (3) above), the learning path in (5) is anticipated for the three target sC clusters.

(4) Markedness hierarchy between SSP-abiding sC sequences: /sl/ > /sn/

(5) Predicted developmental path of sC onset sequences based on sonority: /sl/ > /sn/ > /st

Because the phenomenon investigated in this study – i.e., vowel epenthesis in the Farsi-English IL – is triggered by restrictions on syllable structure, the following discussion will introduce this syllable constituent (including the sC structure) in the context of both Farsi and English phonology.

(sC) Onset clusters in Farsi and North American English

A segmental representation for the syllable structure in Farsi can be formulated as (C) V (C) (C) (where segments between parenthesis are optional) (e.g., Karimi, 1987; Yarmohammadi, 1995). This means that Farsi syllables cannot contain more than four segments, which naturally restrains the number of segments permitted in onset (i.e., syllable-initial) and coda (i.e., syllable-final) positions. Singleton (i.e., 1-segment) onsets can essentially contain any consonantal segment (i.e., those with the feature [+consonantal]) in the phoneme inventory, except for the segment [w]).

While Farsi permits singleton onsets – words such as [bâ] 'with' (i.e., CV); [sir] 'garlic', [xar] 'thorn', [læb] 'lip', and [yar] 'companion' (i.e., CVC); and [râst] 'right' (i.e., CVCC) – it does not allow onset clusters of any type, including sC sequences. The only sC sequences found in the language cluster cross-syllabically, as illustrated in (6b) below (where '.' indicates syllable boundaries).

(6) sC clusters in Farsi

a. No tautosyllabic sC structure (e.g., *[sneik] 'snake' → [**es.n**eik])

b. Only cross-syllabic sC clusters (e.g., [e**s.t**e.kân] 'cup')

Because Farsi syllables allow only singleton onsets, there is always a rise in sonority from the onset towards the nucleus in the language. This is not always the case with the English language, as we will see in the following discussion.

The structure of the syllable shape in North American English (NAE) can be represented as (C) (C) (C) V (C) (C) (C) (C). This suggests that NAE allows up to three onset consonants, and as many as four codas. As with Farsi, almost all [+consonantal] segments in the inventory can syllabify as 1-member onsets; the only exceptions being /ŋ/ and /ʒ/.

Most English 2-segment onsets consist of sequences of stop + liquid (e.g., '**bl**ouse', '**gr**eat'); some English 2-member onsets are made up of sequences of stop + semivowel (e.g., '**tw**in', '**pu**re'). In addition to allowing /s/ + liquid and /s/ + nasal onset clusters, which abide by the Sonority Sequencing Principle discussed in the previous section, English also permits /s/+ stop onset clusters, which violate the same principle. This co-occurrence of the SSP-violating versus SSP-abiding sC onset clusters in English is illustrated in (7).

(7) *2-member sC Onsets in English*: *SSP-abiding vs. SPP-violating Clusters*

SSP-abiding		**SPP-violating**
s + liquid (sl)	s + nasal (sn, sm)	s + voiceless stop (sp, st, sk)
e.g., **sl**ave	e.g., **sn**ail, **sm**ile	e.g., **sp**are, **st**ill, **sk**im

In sum, given that the syllable structure in Farsi disallows sC onset clusters altogether, and that some English sC onsets clusters violate the Sonority Sequencing Principle (in which preferred syllables display both a continuous rise in sonority towards the peak and a decrease in sonority towards the edges), it is no surprise that Farsi speakers have difficulty producing these clusters (see also Yarmohammadi, 1995 for a similar view). In an attempt to resolve this difficulty, these speakers typically insert an epenthetic [e] to break up the illicit clusters, as mentioned previously. Also, as noted earlier, the vowel insertion patterns characterizing the Farsi-English IL speech is an inherently variable process, one that is triggered by linguistic (e.g., sonority markedness, preceding phonological environment) and extra-linguistic factors (e.g., proficiency and level of formality). Let us begin by examining the linguistic factors that may have an effect on the structuring of Farsi-English interphonology.

Previous L2 research: Influence of linguistic factors on IL phonology

This section is devoted to presenting some of the previous studies which have examined the effects of linguistic factors (e.g., sonority profile of the cluster, L1 transfer, preceding phonological environment) on the L2 development of consonant clusters. Although a considerable amount of research has been done to investigate the acquisition of nonnative sC onset clusters in general (e.g., Spanish-English IL – Carlisle, 1988, 1997, 2006; Portuguese-English IL – Cardoso, 2008; Major, 1996; Texeira Rebello, 1997; Korean- English IL – Kim, 2000; Kwon, 2006), there is only one study that investigates the L2 acquisition of the clusters by native *Farsi* speakers (that of Karimi, 1987 – see forthcoming discussion). In addition, aside from one recent study by Cardoso (2008), which involves the development of English sC sequences in the IL speech of Brazilian-Portuguese speakers, we are not aware of any other research examining the acquisition of *homorganic* sC clusters from a variationist perspective, one that incorporates sociolinguistic methodology for data collection and analysis as well as current developments in phonological theory.

The only study that examined Farsi-English IL phonology was conducted by Karimi (1987). In that study, the researcher investigated the production of English sC onset clusters in the speech of four Farsi speakers (three females and a male, from 19 to 55 years of age), using sociolinguistic methodology which included data from three different styles: word-list reading, paragraph-reading task, and informal interview. Overall, the results from this research indicated that the word list, the most formal task, yielded the slightest proportion of errors (i.e., e-epenthesis), followed by paragraph reading and informal conversation. Most important, the findings also suggested that, in attempting to pronounce English sC clusters, the Farsi speakers had consistently used e-epenthesis.

There are some problems in Karimi's study above. For one thing, the sample size involved was relatively small: It included only four participants. In addition, the researcher did not supply enough information as to how proficiency had been measured; in fact, she simply mentions that all her informants had had English in tutored settings from three to six years before coming to the United States. Finally, Karimi did not explicitly address the question of how linguistic knowledge (e.g., *markedness on sonority*, *phonological environment*) affects the order of acquisition of the nonnative sC sequences.

In a study involving Spanish / English interphonology, Carlisle (1988) investigated the production of /sl/, /sn/, and /sm/ onset clusters, which are in a markedness relationship based on an implicational relationship between obstruent + liquid onsets and obstruent + nasal onsets (Greenberg, 1965) – the latter presupposing the presence of the former and thus being more marked and, consequently, less preferred. Drawing on this implicational universal, Carlisle predicted that /sn/ and /sm/ clusters should be modified via e-epenthesis more frequently than /sl/ sequences. To test the prediction, fourteen native speakers of Spanish each read 435 topically unrelated and randomly ordered sentences, each containing one occurrence of the three onsets. The reading task was carefully designed by the researcher to allow tighter control of the preceding phonological environments (i.e., vowels and consonants) that occurred before each onset. In accordance with the hypothesis, the results of the study revealed that the Spanish speakers modified onset clusters that are more preferred universally significantly less frequently than they did those that are less preferred (i.e., /sl/: 29 %; /sn/: 33%; and /sm/: 38%).

In another study, Carlisle (2006) examined the acquisition of English /st/, /sn/, and /st/ clusters by 17 adult native Spanish speakers.[1] The main purpose of the study was to determine whether syllable universals – i.e., Sonority Sequencing Principle (SSP) and Minimal Sonority Distance (MSD) (Clements, 1990) – have an effect on the acquisition of the target clusters. Two main hypotheses guided Carlisle's study: (1) /sl/ and /sn/ would be modified less frequently than /st/, the latter violating the SSP; and (2) /sl/ would be modified less often than /sn/, the former exhibiting a higher MSD value. Overall, the results strongly confirm the role of Clements' (1990) principles based on markedness (i.e., the Sonority Sequencing Principle and the Minimal Sonority Distance) in predicting order of acquisition of the sC clusters.

There are two main shortcomings with the Carlisle studies above. First, these studies have generally been concerned with the examination of *linguistic* variables only, to the neglect of extra-linguistic variables and the interaction between the two. A second issue with Carlisle's research is that it tends to investigate only the *proportion* of e-epenthesis, with no examination of the actual patterns of variation that characterize the acquisition of sC onsets. Notwithstanding the omissions above, Carlisle's research – particularly his (2006) study – seems to exhibit a unique feature: its inclusion of a homorganic set of clusters (/st/, /sn/, and /sl/), which all share the coronal articulator. Somewhat surprisingly, however, there appears to be no evidence from the investigation suggesting that the choice of the homorganic sC sequences was an overt attempt to control for place of articulation. Unlike Carlisle's research, and along the lines of Cardoso (2008; see following discussion), an important aspect of our study lies in its exclusive and explicit focus on the *homorganic* /st/, /sn/, and /sl/ onset clusters, the rationale being that this would avoid any confound effect of *place of articulation* on the production of the clusters.

As implied in our previous discussion, the only sC cluster acquisition study that has attempted to control for place of articulation is the one carried out by Cardoso (2008). Using a sociolinguistic methodology for data collection and analysis (typical of variationist research), Cardoso examined the variable development of the *homorganic* /st/, /sn/, and /sl/ onset clusters in the IL speech of 10 native Brazilian Portuguese speakers

[1] In a sense, Carlisle's (2006) study is a combination of two of his earlier studies: Carlisle (1988), in which the onset clusters /sl/, /sn/, and /sm/ were investigated; and Carlisle (1991b), where the /st/ and /sl/ sequences were examined.

learning ESL. An important contribution of this research (as suggested earlier) concerns the researcher's selection of homorganic sC clusters: As emphasized by the author, the choice of this specific type of sC sequences was intended as a heuristic measure to ensure that sonority was the only markedness feature upon which the three target clusters differed.

Findings from Abrahamsson (1999)'s longitudinal case study of one L1 Spanish / L2 Swedish learner appear to contradict the results reported in Carlisle's (1988, 1997) research, particularly with regards to the effects of sonority markedness. Indeed, at odds with the hypothesis that a high degree of sonority in the segment following the /s/ would trigger lower proportions of e-epenthesis, Abrahamsson reported that /sl/ clusters were epenthesized *more* often than were /sn/ clusters, though the difference was not statistically significant. These idiosyncratic findings aside, Abrahamsson nonetheless acknowledged that his corpus contained only 44 instances of /sl/ against 67 instances of /sN/ (with N designating the /n, m/ nasals). Although the researcher did find, in accordance with Carlisle (1991a), that epenthesis occurred significantly more frequently before word-final consonants than after word-final vowels, he had not actually controlled for the type and number of preceding environments. To help control for the quality and quantity of preceding environment, the reading (formal) task designed for our study includes a list of sentences containing the target onset clusters /st, sn, sl/, *equally* distributed among the three different environments – vowel, pause, consonant.

To trace the relative effects of L1 transfer and markedness principles on IL phonology, Broselow (1983) investigated the L2 acquisition of English onset clusters by speakers of two varieties of Arabic – Egyptian Arabic and Iraqi Arabic. With regard to Iraqi speakers, the researcher found that the general tendency was to insert an epenthetic [i] before sC clusters, irrespective of whether or not these clusters abide by the sonority principle (i.e., /sC/ → /i.sC/). This particular finding was interpreted by Broselow as strong evidence in favor of the influence of L1 transfer.[2] With regard to Egyptian speakers, the investigator found that the regular

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[2] It is noteworthy that, unlike Egyptian Arabic, which proscribes initial consonant clusters altogether, Iraqi Arabic optionally allows them. In Iraqi Arabic, clusters are often realized variably: either via i-epenthesis (e.g., [iθn]een) or through its target L2 pronunciation (e.g., [θn]een – Iraqi equivalent for the English word 'two'). This implies that insertion of an epenthetic [i] before onset sequences is a productive rule of Iraqi Arabic.

pattern was to insert an epenthetic [i] b*efore* sC clusters which violate sonority (i.e., /sC/ → /i.sC/), and an epenthetic [i] *between* the segments of sC clusters which abide by sonority (i.e., /sC/ → /siC/). Comparing the two modification patterns outlined above, Broselow concludes that the latter pattern observed among Egyptian speakers (i.e., /sC/ → /siC/) could not possibly be ascribed to a native phonological rule; hence the importance of markedness criteria in the IL speech of yet another group of learners – native speakers of Egyptian Arabic.

A major problem in Broselow's (1983) study is her tendency to reduce markedness to violation of sonority. Obviously, there is more to markedness than just violation of sonority. For instance, both /sl/ and /sn/ (which are included in the current study) abide by sonority, and yet the former is less marked than the latter because it has as its *second* element a liquid – /l/ – which has a higher sonority value (closer to that of a vowel). On the other hand, the second segment in the /sn/ cluster – /n/ – has a lower sonority value (which is farther away from that of a vowel), making it less preferred and thus more marked. That is, aside from the Sonority Principle, and in line with the Minimal Sonority Distance parameter reviewed earlier, a strong universal tendency exists for the second segment in an onset cluster to be *high* in sonority.

Escartin's (2005) study, discussed at the outset, is worth reviewing here, as it offers insights into the influence of linguistic variables on L2 phonological acquisition. Using a variationist design, Escartin investigated the development of all sC English onset clusters in the speech of Mexican Spanish learners of ESL. Although Escartin predicted, based on sonority markedness, that e-epenthesis before sC onsets would be lower the higher the degree of sonority of the segment following the /s/ (i.e., /sl/ > /sn/ > /st/), the statistical results showed no significant difference between /sl/ and /st/ sequences (.52 and .54, respectively). This is quite surprising given that /st/ clusters, which violate sonority sequencing, were expected to be modified more often than the sonority-abiding /sl/ clusters. Escartin accounts for the unexpected results in terms of the interaction effects between the variable constraints sC sonority and preceding environment. In particular, Escartin argues that the relatively high proportion of e-epenthesis in /sl/ clusters after *consonants* (44%) suggests that preceding environment is a more powerful factor than sC sonority markedness in inducing e-epenthesis (Carlisle, 1991b).[3] The researcher also invokes word

[3] Unlike Escartin (2005), Carlisle (1991b) reported a significantly lower proportion of e-epenthesis before /sl/ (.25) than before /st/ (.36).

frequency effects, claiming that the infrequent occurrence of /sl/ clusters in English (e.g., in teacher talk) might have had a negative effect on the observed results.

Escartin (2005) also found that, in line with several other studies (e.g., Carlisle, 1991a, 1997, 2006; Cardoso, 1999, 2008), preceding consonants induced the highest proportion of epenthesis (.59), and preceding vowels the lowest (.34). In addition, and contrary to Abrahamson's (1999) findings that preceding pauses have a 'neutral' effect on the amount of epenthesis, Escartin reported a relatively high level of vowel epenthesis after pauses (.55). Based on these results, and along the lines of Cardoso (1999), we hypothesize that consonantal and pause environments will have a relatively similar effect of increasing the likelihood of e-epenthesis, and that vocalic environments will have a comparatively lowering effect, inducing the lowest proportion of epenthesis.

Two other studies involving Lusophone speakers learning ESL (Major, 1996; Texeira Rebello, 1997) have reported quite unpredictive results regarding the influence of sonority markedness on the production of nonnative sC clusters – namely that the SSP-following onset clusters were modified more often than their SSP-violating counterparts. For example, in Major's study, which involved four native Brazilian Portuguese (BP) participants, it was found that /s/ + liquid onset clusters contributed more significantly to error than /s/ + stop onset sequences did. Based on evidence provided by Major and Texeira Rebello, it appears that the so called anomalous findings were the result of the positive transfer of two interacting rules in BP which induced target-like sC production (for details about these rules, see Carlisle, 2006).

Despite the unexpected results reported in the two studies above, the general findings of previous research reveal that onset clusters that did not abide by the SSP were epenthesized more often than those that did. In addition, the findings also suggest that preceding consonantal environments induce the highest proportion of e-epenthesis, while vocalic environments the lowest. Let us now turn to the effects that extra-linguistic factors may have on IL phonology.

Previous L2 research: Influence of extra-linguistic factors on IL phonology

In addition to the linguistic factors discussed above, extra-linguistic factors (e.g., style, proficiency, gender, ethnicity, and social class) have also been known to contribute to variation in L2 acquisition (e.g., Bayley &

Preston, 1996; Cardoso, 2007; Dickerson & Dickerson, 1977; Gatbonton, 1978; Tarone, 1979; Beebe, 1980; Major, 1996, 2001). To better understand the effect of external variables on IL phonology, we suggest introducing the Ontogeny Phylogeny Model (OPM; Major, 2001), an updated version of the Ontogeny Model (OM; Major, 1987). The OPM is based on the premise that developing interlanguages are comprised of both L1 and L2 features, which are mediated by universal (developmental) phenomena. The OPM maintains that the IL develops *chronologically* such that features from the L2 increase, L1 patterns decrease, and developmental phenomena increase and then decrease in the course of L2 development. Likewise, the OPM claims that IL varies *stylistically* such that in more formal styles, L2 structures increase, L1 features decrease, and developmental phenomena increase and then decrease. Graphic representations of the OPM predictions are illustrated in Figure 1.

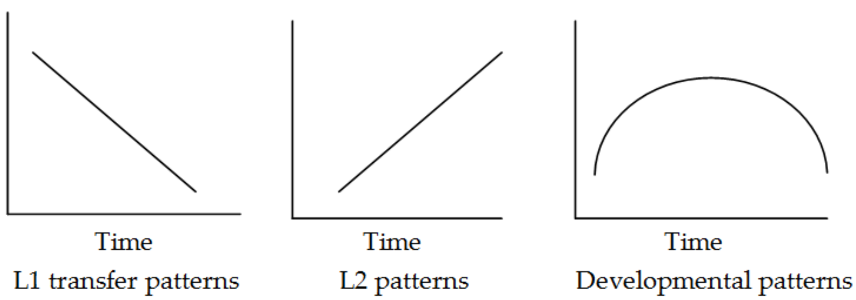

Figure 1. The Ontogeny Phylogeny Model of L2 acquisition.

As is the case with style, the development of proficiency has also been shown to influence L2 phonology. Abrahamsson's (1999) study is a case in point. The main aim of the study was to confirm and extend the results reported in Carlisle's (1997) research (in which *only* a formal type of speech was used) to conversational speech data. Despite Abrahamsson's prediction (based on a chronological corollary of the OPM discussed above) that the proportion of e-epenthesis (i.e., L1 transfer) would decline with increased L2 proficiency, the results showed an altogether different pattern. His results revealed a low proportion of e-epenthesis at the beginning of data collection (recording time 1), a relatively increasing rate of the phenomenon during the first year (recording times 1-9) and a decreasing frequency of vowel insertion during the second year (recording time 10).

To elucidate this rather unexpected pattern – namely, the 'low-high-low' pattern of e-epenthesis – Abrahamsson (1999) suggested the possibility of a nonlinear development of the L2 structures analyzed in his study. In particular, he ascribed the pattern of development from low to high frequencies of epenthesis during the first year to increased speech proficiency; during that period, learners may have focused more on content than on form, thereby producing more erroneous forms in the process. On the other hand, he attributed the decline in error rates during the second year to real learning. That is, over time when L2 fluency has increased, errors begin to disappear. Assuming that e-epenthesis is a transfer phenomenon in the case of L1 Farsi speakers (e.g., Yarmohammadi, 1995), in the current study we predict that the initial state will strictly correspond to the phonology of Farsi, in which sC clusters will syllabify via e-epenthesis (just like in the L1). At more advanced stages, however, the frequency of e-epenthesis will decrease, as predicted by the OPM.

Finally, another study which has adopted a holistic approach to investigate L2 phonological phenomena was conducted by Cardoso (2007). In that study, the researcher examined the variable acquisition of word-final stops by 6 adult native Brazilian Portuguese speakers learning ESL in a classroom context. As hypothesized, the results of the study indicated that the target-like production of English codas is more likely to occur in the speech of more *proficient* speakers and in more formal *stylistic* environments, which conforms to the predictions of Major's (2001) Ontogeny Phylogeny Model for L2 acquisition discussed earlier. More important, the findings in Cardoso's study bolster the idea that L2 development is a complex process whose understanding entails not only a detailed examination of linguistic variables but also a wide appeal to (and investigation of) extra-linguistic constraints. Along the lines of Cardoso (2007), the current investigation adopts an integrated approach to analyze the Farsi-English data, because this approach (as the discussion above suggests) allows us to provide a more thorough analysis for the acquisition of L2 phenomena (i.e., e-epenthesis).

RESEARCH QUESTIONS AND HYPOTHESES

What essentially emerges from our previous discussion is that the development of sC clusters (and its associated phenomenon of e-epenthesis) in IL is determined by preceding phonological environment, the sonority profile of the sC cluster, L2 proficiency, and style. More precisely, the survey of previous research leads us to formulate the following research questions: (1) Does sonority markedness have an impact on the acquisition of sC onset clusters by Farsi speakers learning ESL? In particular, does the acquisition of these sC sequences proceed from the less marked sonority-following sequences (i.e., /sl/ and /sn/) to the more marked sonority-violating onset clusters (i.e., /st/)? (2) Is the phenomenon of e-epenthesis sensitive to *preceding phonological environment* (i.e., consonant, pause, vowel)? What is the effect of each environment on the phenomenon? (3) How is e-epenthesis patterned across the three proficiency groups (beginner, intermediate, advanced)? (4) To what extent is e-epenthesis determined by stylistic factors?

The set of hypotheses stemming from the above questions are: (1) Based on the sonority profile of the cluster and markedness, the development of sC onset clusters will follow the following sequence: /sl/ > /sn/ > /st/. (2) Epenthesis will occur more frequently after word-final consonants and pauses than after word-final vowels. (3) There will be a decline in the amount of e-epenthesis as L2 proficiency rises. (4) The frequency of e-epenthesis will be higher in less formal tasks.

In the next section, we will present and discuss the methodological framework used to address the research questions and hypotheses stated above.

METHODOLOGY

Participants

The participants (who were living in the Montreal area at the time of the data collection) were 30 native speakers of Farsi (15 male and 15 female), with an age range between 19 and 42 (average age = 26). All participants were selected from a university-educated population, and all had formally studied English for several years, especially in middle- and/or high-school (3 years was the baseline, as had been attested in the participants' responses to a questionnaire). Three measures of English proficiency were administered to the participants, two of which were general in nature: (1) a preliminary (i.e., pre-experimental) informal conversation between the researcher and the informants, to allow the researcher to get a sense of the global speaking proficiency of the participants; (2) a self-evaluation procedure, whereby participants had to rate their own speaking ability in English, according to a scale from 0 (very poor) to 5 (very good) (as part of their requirement to fill out the background questionnaire).

Because the current study examines a specific aspect of L2 pronunciation – namely, the acquisition of English sC clusters – a *more* specialized proficiency measure, aside from the two general procedures mentioned above (i.e., self-assessment and global proficiency), was needed. The measure, which was incorporated as part of the data collection process, allowed the *overall* frequency of correct production of the target sC onset clusters (i.e., /st/, /sn/, and /sl/) to be calculated for each participant, consistent with a principle widely used in L2 phonological research (e.g., Andersen, 1978; Carlisle, 1997; Eckman, 1991; John, 2006).[4] Based on the three selection criteria suggested above – *cumulative sC production*, *self-assessment*, *global proficiency* – three distinct proficiency groups of 10 participants each were *ultimately* established (see Figure2).

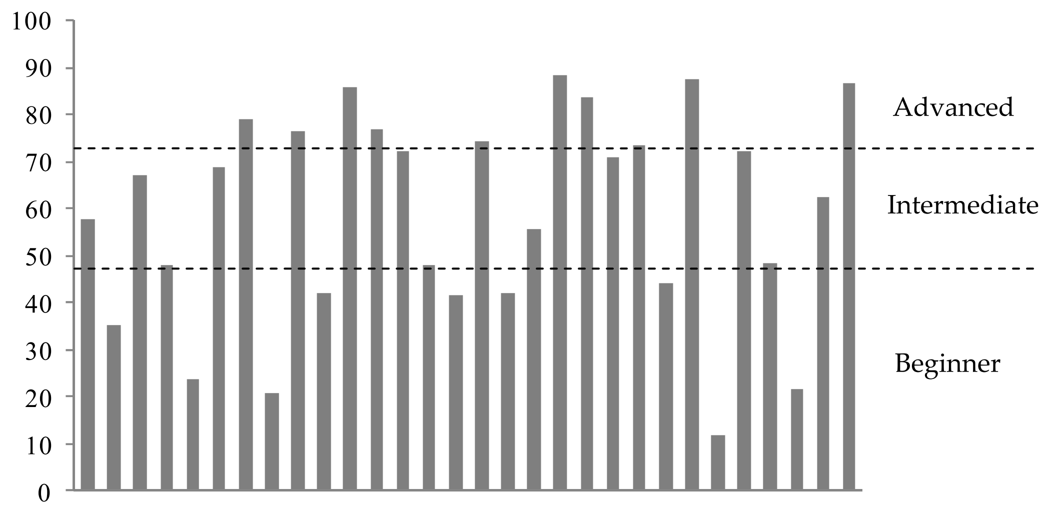

Figure 2. Ultimate proficiency in English & participants, following three criteria: cumulative sC production, self-assessment, and global proficiency.

Materials

Aside from a background questionnaire, the materials used for the data collection in this study consisted of a formal reading task as well as an

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[4] Unlike previous research which has used the (20 - 80%) interval of correct production as the criterion level to define and investigate intermediate proficiency *only* (e.g., Carlisle, 1997; Eckman, 1991), the present study includes a more comprehensive range (0 -100%), from which three proficiency groups (beginner, intermediate, and advanced) are sampled.

informal interview. The formal task involved reading a list of 59 topically unrelated sentences containing the three onset clusters /st/, /sn/, /sl/, *equally* distributed among the three different preceding environments included in this study – vowel, pause, consonant. The decision to include a relatively even number of vowels, pauses, and consonants before each of the target sC clusters is motivated by findings from a number of IL studies which have established that phonological phenomena are largely determined by preceding phonological environment (e.g., Cardoso, 2005, 2007; Carlisle, 1991a, 1991b, 1997; Escartin, 2005; John, 2006). The reading task lasted from 5 to 10 minutes to complete.

Participants also took part in an informal, picture-based interview which was administered by the researcher in English. The purpose of the interview was to obtain as 'natural' data as possible and to minimize the effect of the observer's paradox (Labov, 1972) – a situation in which the participants' performance becomes affected because of their awareness that they are being watched or audio-recorded. To avoid such a situation and make certain that less careful speech is obtained, the informal interview used pictures (of relatively frequent words such as 'cat', 'airplane', and 'snake') as cues to engage 'friendly' conversations between the researcher and the respondents. In addition to utilizing images that contained the target sC cluster words, the interview task also included picture distractors, to reduce the likelihood of participants guessing the exact nature of what was being elicited from the pictures and, therefore, minimize any threats to internal validity. The task lasted approximately 25 minutes.

Procedure

The participants were individually tested between April and September, 2007, in an office at Concordia University, or at some other location (e.g., in offices at other institutions), depending on room availability and other factors. Each session started with a presentation of the general goals of the study, with no revelation of the precise focus or true nature of the investigation. After officially consenting to participate in the study, each participant was handed out a written questionnaire which he or she had to fill out. Following this, and in order to minimize any potential test effects, it was decided to counterbalance the ordering of both the formal and informal tasks. That is, some respondents started with the formal task before engaging in the informal interview, while others did just the opposite.

Data recording and transcription

Both the formal and informal tasks were recorded via a CD recorder (Marantz CDR300) and an audio-Technica lavaliere microphone (AT831b). The recorded data were then transcribed by the researcher via Transcriber (version 1.5.1), an application for labeling, segmenting, and transcribing speech. In particular, preceding environments, type of onset clusters, and presence or absence of e-epenthetic were transcribed.

GOLDVARB X RESULTS

Following transcription of the data, the collected 4,149 tokens were coded according to the coding protocol shown in Table 1. The coded tokens were then submitted for a series of Goldvarb X (Sankoff et al., 2005) statistical analyses, to determine the probabilistic contribution of each of the linguistic and extra-linguistic factor included in the study.

Briefly, Goldvarb X is a statistical package which, unlike other statistical procedures that are capable of handling only controlled and balanced data (e.g., ANOVA), is suitable to manage the type of imbalanced data collected and analyzed in this study. In so far as the body of data collected is a representative sample of the population under investigation, the analysis should extend to all similar speakers and linguistic and extra-linguistic contexts.

Table 1. Factor Groups and Coding Scheme for Goldvarb X Analysis

Factor	Factor Groups		
Dependent variable	Epenthesis	Target form	
sC sonority	s + liquid	s + nasal	s + stop
Preceding environment	Consonant	Vowel	Pause
Proficiency	Beginner	Intermediate	Advanced
Style	Formal	Informal	
Participants	#1	#2	#3, etc.

Final Goldvarb X results: A summary

The final probabilistic results from the Goldvarb statistical analysis (in weights), illustrated in table 2 below, indicate that the application of e-epenthesis is favored in the speech of less advanced learners (e.g., beginners: .79), when the type of speech is less formal (e.g., informal: .62), when the sC cluster is /st/ or /sn/ (.60 and .51, respectively), and when the cluster is preceded by a consonant or pause (.68).

Table 2. Significant Goldvarb Results: Probability of e-epenthesis ($p < .05$)

Factor Groups	Factors		
Preceding environment	Consonant/pause **0.68**		Vowel 0.17
sC sonority	s + nasal **0.51**	s + liquid 0.35	s + stop **0.60**
Style	Formal 0.35		Informal **0.62**
Proficiency	Beginning **0.79**	Intermediate 0.47	Advanced 0.23

Interpreting the results: Linguistic factors

The first hypothesis, based on the effects of sonority on IL, posited that the acquisition of the sC onset clusters would follow the sequence /sl/ > /sn/ > /st/ (where '>' indicates 'more easily articulated and thus acquired earlier than'). Specifically, the original prediction was that L2 learners should acquire the less marked and sonority-abiding clusters (i.e., /s/ + liquid and /s/ + nasal onset clusters) before the more marked and sonority-violating clusters (i.e., /s/ + stop onset clusters), based on Clements' (1990) Sonority Sequencing Principle (SSP). The expectation was also that the least marked clusters /sl/ would surface before the relatively more marked /sn/ clusters, following Clements' (1990) Minimal Sonority Distance (MSD) discussed earlier. The results from the current study indicate that, contrary to expectation, /s/ + nasal onset clusters induce nearly as much error (i.e., e-epenthesis) as /s/ + stop sequences do (.51 and .60, respectively). In addition, and as expected, the findings also show that /s/ + liquid onset sequences do not exhibit a significant effect on the occurrence of e-epenthesis (see table 3 below for an illustration of these results – repeated from table 2 for ease of exposition).

Table 3. Significant Goldvarb Results for the Factor Group sC Sonority

sC clusters	Probability of e-epenthesis
s + liquid	.35
s + nasal	**.51**
s + stop	**.60**

After examining the above results, the following question must be asked: Why do the Farsi learners pattern the SSP-abiding /s/ + nasal onset clusters together with the SSP-violating /s/ + stop onset clusters, instead of grouping the former together with the (equally) sonority-abiding /s/ + liquid clusters, as hypothesized earlier?

Clearly, a sonority-based account, which predicts a development pattern of less marked SSP-following versus more marked SSP-violating onset sequences (i.e., /sl/, /sn/ > /st/), cannot adequately account for the sC acquisition hierarchy observed in this study (i.e., /sl/ > /sn/, st). Instead, the answer seems to lie in a phonetically-based approach to phonology (e.g., Hayes, Kirchner, & Steriade, 2004), which can capture complex phonological phenomena by appealing to their underlying phonetic conditions. A phonetically-based account of the acquisition of sC onset clusters, in particular, draws on core phonetic principles which explore the relationship between the relative markedness of the sC clusters and the degree of *gestural effort* involved in their articulation (e.g., Kirchner, 1998).

In other words, this phonetically-oriented view of markedness permits us to establish an acquisition hierarchy that takes into account the degree of articulatory effort made in producing each of the three onset clusters involved in our study: /st/, /sn/, and /sl/. In particular, this alternative view of markedness, which is based on the articulatory feature *continuancy* (i.e., the freedom of airflow through the oral cavity), allows us to advance the following argument: Given that the production of /st/ and /sn/ onset clusters entails more gestural effort (i.e., a transition from [+continuant] to [-continuant] – see forthcoming discussion) than the articulation of /sl/ (in which continuancy remains constant), the latter sequence is considered less marked and is therefore expected to be acquired earlier in the learning process. The markedness hierarchy observed across the three target sC onset clusters /sl, st, sn/ is illustrated in (11), following the continuancy-based analysis just outlined.

(11) Markedness on continuancy & acquisition order of English clusters:

[+continuant] [+continuant]	>	[+continuant] [-continuant]
sl		**sn**, **st**

Before getting into the specifics of how markedness on continuancy is able to capture the sC development (and hence the e-epenthesis) patterns obtained in this study, we propose a more elaborate definition of the concept of *continuancy*, one which closely relates to the articulation of each segment in the target cluster sets (/sn/, /st/, /sl/).

For example, in articulating the sound /s/, both the tip of the tongue and the alveolar ridge are brought very closely together, resulting in air being forced out of the mouth through a very narrow passageway. This close contact creates a relatively high pressure, aside from the friction noise. Because air can still flow through the vocal tract when /s/ is articulated, this sound is referred to as [+continuant]. Also included in the [+continuant] category is the liquid /l/ – a sound which is made with the *central* part of the articulators (the tip of the tongue and the alveolar ridge) touching each other, and the sides of the tongue being pulled down slightly from the roof of the mouth. This articulation of the liquid /l/ results in air being expelled along the sides of the tongue, hence the term *lateral*. That the lateral liquid /l/ is categorized as [+continuant] is based on a more liberal definition of continuancy, one which states that a continuant sound is made whenever air can flow through *any* part – not necessarily the middle – of the mouth unobstructed (e.g., Ladefoged, 1993; Spencer, 1991). Let us now look at how stop sounds are articulated with respect to continuancy.

In making stop sounds, as in the case of the anterior coronals /t/ and /n/, the air is completely blocked from passing through the mouth. For example, in making the oral sound /t/, the alveolar ridge comes into close contact with the tip of the tongue, preventing the air from escaping through the mouth and creating pressure (which results in the production of a [-continuant] segment). Similarly, in making the sound /n/, the alveolar ridge and the tongue tip are brought together and the soft palate is lowered, blocking the passage of air from the oral cavity and allowing it instead through the nasal opening (which also yields *a [-continuant]* sound).

Now that we have described the articulation of each individual segment involved in our study, the next step is to examine how the segments are realized *in coordination* within their respective sC cluster groups and, more importantly, with regard to continuancy. To use simple terminology, [st], [sn] are articulated by making a [+continuant] sound for [s] and then *halting* it during the production of the [-continuant] [n] and [t]. In making the [sl] sequence, however, the [+continuant] feature remains unchanged across the articulation of the two sounds. Comparing the two previous articulation patterns, one could fairly claim that, because of the obstruction process that follows the articulation of the [+continuant] sound /s/ when pronouncing /st/ and /sn/, a relatively higher effort cost (due to higher articulatory pressure) is involved. In terms of language acquisition, this means that when language users attempt to pronounce clusters that are [+continuant +continuant], they normally need not deploy as much articulatory effort as when they produce [+continuant –continuant] onsets – the articulation involved in the latter set requiring an abrupt reversal of continuancy.

Let us now see how the results pertaining to the continuancy feature elaborated above fit within the general findings of the literature on L2 speech. An inspection of the literature, particularly that which concerns the effects of sonority markedness on the nonnative acquisition of sC clusters, reveals a mixed bag of results. While some studies have turned up results consistent with the predictions of the Sonority Sequencing Principle (SSP) (e.g., Cardoso, 2008; Carlisle, 1988, 2006; Eckman & Iverson, 1993; Tropf, 1987), other studies have reported sC production patterns in the form of more marked s + liquid/s + stop versus less marked /s/ + nasal onset clusters (e.g., Abrahamsson, 1999; Escartin, 2005). To our knowledge, the present investigation is the first *L2 adult* acquisition study to establish the rather unorthodox markedness hierarchy in the form of more marked s + nasal/s + stop onsets (i.e., s + [-continuant]) versus less marked /s/ + liquid onsets. Evidence for such a grouping, however, can be found in data from studies of L1 acquisition (e.g., Ben-David, 2006; Gierut, 1999; Grunwell, 1981; Ingram, 1989; Smit, 1993; Yavas & Beaubrun, 2006; Yavas & Someillan, 2005).[5]

For example, in her investigation of the acquisition of sC clusters by 11 small children exhibiting functional phonological delays, Gierut (1999) reported some of her participants grouping together consonant clusters whose member segments had a sonority distance of 2 or less. Consistent with our results, Gierut found a consonant cluster patterning of the type s + stop/s + nasal versus s + liquid/s + glide. Likewise, Smit (1993) reported a relatively similar sC grouping arrangement – i.e., s + stop/s + nasal clusters versus other sC sequence types – among the children she investigated in her study. Finally, and strikingly similar to our findings, Yavas and Someillan (2005), who investigated the production of English sC onset

[5] Although Gierut (1999) found a similar sC cluster grouping of s + nasal/s + stop onsets (i.e., s + [-continuant]) versus /s/ + liquid onsets (i.e., s + [+continuant]), she nonetheless reported *a reversed* path of acquisition for the two types of onsets. That is, unlike the data from our study, Gierut's data showed evidence of earlier acquisition of s + nasal/s + stop onsets before /s/ + liquid onsets.

sequences by 15 Spanish-English bilingual children, found a binary grouping of problematic s + stop/s + nasal clusters versus less problematic s + liquid/glide sequences. As was the case with the L1 studies reviewed above, the observed sC acquisition pattern in the latter study was also attributed to a binary split between s + [-continuant] versus s + [+continuant].

Having accounted for the study's results in terms of the linguistic factor sC sonority, we will now discuss the results with regards to the second linguistic factor – *preceding phonological environment*. Recall that the second hypothesis in our study predicted that e-epenthesis would occur more frequently after word-final consonants and pauses than after word-final vowels. The findings of the present study (see table 4 below, repeated from table 2 for ease of exposition) corroborate our initial hypothesis, as confirmed by the results for the preceding consonant/pause set (0.68)). The results with respect to preceding vowels (0.17) also support the original prediction that vocalic environments should have a facilitating effect, incurring the lowest amount of epenthesis.

Table 4. Significant Probabilistic Results for the Factor Group Preceding Environment

Preceding Environment	Probability of e-epenthesis
Consonant/Pause	**0.68**
Vowel	0.17

It is important to emphasize at this point that the general findings of this study in relation to preceding phonological environment – namely that consonants as much as pauses favor the occurrence of errors – is not in any way a revelation: A number of other variation studies have reached the same conclusion (e.g., Cardoso, 1999; Escartin, 2005; Winford, 1992).

In the following section, we will discuss the results obtained in light of the two extra-linguistic factors deemed significant by the analysis: proficiency and style or level of formality.

Interpreting the results: The extra-linguistic factors

The third hypothesis of our research predicted a decline in the rate of e-epenthesis with increased L2 proficiency. In accordance with this hypothesis, the Goldvarb results indicate that the amount of e-epenthesis is inversely proportional to the level of proficiency. More specifically, these results reveal a decrease in e-epenthesis application from 0.79 in the beginner group to 0.22 in the advanced group. This decreasing pattern in error production across the higher proficiencies should, however, come as no surprise: With increased exposure to L2 speech, one would normally expect an improvement in pronunciation (see discussion below).

Interestingly, this observed pattern of L2 improvement (and the corresponding decline in error production) is exactly what is foreseen by the developmental corollary of the Ontogeny Phylogeny Model (Major, 2001). As mentioned earlier, the Ontogeny Phylogeny Model (OPM) predicts that over time (hence with increased proficiency) and as style becomes more formal, L1 features (e.g., e-epenthesis) decrease while L2 features (e.g., sC production) increase. To illustrate how the OPM captures the Farsi-English data in our study, two graphs are juxtaposed in Figure 3: While the darker line shows a decrease in L1-based e-epenthesis patterns across the three levels of proficiency, the shaded line indicates a rise in target sC production patterns across the same proficiency groups.

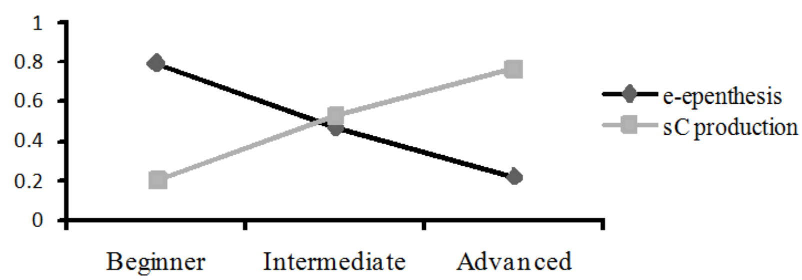

Figure 3. Rise in sC cluster production vs. a decline in e-epenthesis across proficiencies.

Taken together, the findings above suggest that with increased proficiency, there is a decrease in transfer (i.e., e-epenthesis), which corresponds to an increase in target-like production of sC clusters. These findings confirm the results from several other studies of IL variation (e.g. Bunta & Major, 2004; Cardoso, 2005; Escartin, 2005; Major, 2001, 2004).

In addition to proficiency, the external variable *level of formality* was also shown to have a conditioning effect on the variable application of e-epenthesis. The factor weights for the two stylistic factors considered in this study are illustrated in table 5.

Table 5. Significant Probabilistic Results for Style

Style	Probability of e-epenthesis
Formal	0.35
Informal	**0.62**

What the statistical results in Table 5 tell us is that e-epenthesis is more likely to occur in more informal stylistic environments (.62) and, consequently, that sC onset clusters are more likely to surface as such in more formal stylistic environments. This pattern is in agreement with the fourth hypothesis of our study, namely: that the frequency of e-epenthesis will be higher in less formal tasks. What the probabilistic results in Table 6 cannot tell us, however, is how the formality and proficiency variables interact in their contribution to the observed patterns of variation. For a better understanding of how e-epenthesis is distributed across proficiencies and the two stylistic levels considered in this study, we explored the intersection between the external variables *level of formality* and *proficiency* via cross-tabulations. The results in the form of chart columns (corresponding to the three proficiency levels and two styles) are illustrated in Figure 4.

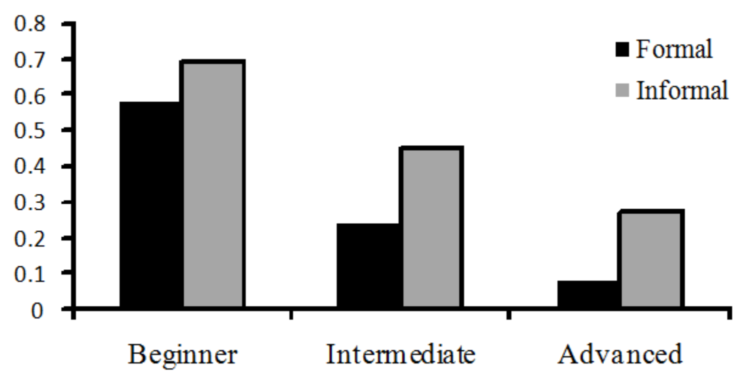

Figure 4. Distribution of e-epenthesis by proficiency and style (%).

It is clear from Figure 4 that the application of e-epenthesis by the Farsi participants decreases as proficiency increases, and increases in informal tasks. The higher proportion of target-like structures in more formal stylistic settings confirms a similar pattern observed in the variationist literature (e.g., Cardoso, 2005, 2007; Gatbonton, 1978; Major, 2004; Schmidt, 1977; Tarone, 1988; cf. Beebe, 1980; Lin, 2001; Major, 1994, 1996; Weinberger, 1987). It also supports the common sociolinguistic view that more target-like or 'prestigious' forms are often correlated with more formal registers (e.g., Cardoso, 2003, 2007; Dickerson & Dickerson, 1977; Labov, 1966; Oostendorp, 1997; cf. John, 2006).

Another generalization that can be made, based on Figure 4 above, is that while intermediate and advanced learners show significant stylistic differences, beginning learners exhibit relatively fewer such distinctions. This smaller stylistic difference (observed in the beginner group) should not, however, be taken as evidence that beginning learners display a single (near-) categorical grammar (cf. Cardoso, 2007).[6] Indeed, the bars in Figure 4 attest to the variable character of the two styles in the group of Beginners: There is 70% likelihood of e-epenthesis occurrence for the Beginner informal grammar, against 60% probability for the Beginner formal grammar. Finally, the cross-tabulation results from Figure 4, especially those concerning the lower frequency of e-epenthesis (i.e., L1 transfer) in more formal styles (and, conversely, the higher proportion of sC cluster production in more formal styles), provide further evidence for the robustness of Major's (2001) OPM model for L2 acquisition, as discussed earlier in this section.

We have demonstrated in this section that the variable application of e-epenthesis in the English IL speech of Farsi speakers is determined by a combination of linguistic (i.e., markedness on continuancy and preceding phonological environment) and extra-linguistic factors (i.e., proficiency and formality). In particular, we have shown that e-epenthesis is more likely to occur in the speech of less proficient speakers, in less formal styles, in s + stop/s + nasal clusters, and in sC clusters preceded by a consonant or pause.

CONCLUSIONS

In this paper, we have examined the variable phenomenon of e-epenthesis in Farsi speakers' production of three homorganic sC onset consonant clusters (/st/, /sl/, and /sn/), using a multidisciplinary perspective that combines insights from first and second language acquisition, formal phonology, phonetics, as well as methodological tools from variationist sociolinguistics. The overall results suggest that, similar to what is usually

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[6] Contrary to the current study, Cardoso's (2005, 2007) studies found that the grammar of beginner learners is characterized by *monostylism*, a situation in which style distinctions are almost inexistent in the speech of early L2 (and even L1) learners.

observed in natural languages, the phenomenon of e-epenthesis is systematic (i.e., predictable), and more importantly, motivated by a combination of linguistic and extra-linguistic variable constraints. In particular, the results reveal that e-epenthesis in Farsi-based IL is more likely to occur: (1) when the sC sequence is preceded by consonants or pauses, (2) in the IL of less proficient speakers, (3) in less formal stylistic environments, (4) and in /s/ + stop and /s/ + nasal sC clusters.

The results involving *markedness on sonority* – namely that e-epenthesis is more likely to occur in /st/ and /sn/ sequences – were somewhat surprising because they did not conform to the predictions of Clements' (1990) markedness-based Principles of Sonority Sequencing (SSP) and Minimal Sonority Distance (MSD), as hypothesized. These results, in particular, showed that the SSP-abiding /sn/ clusters were almost as difficult to acquire as their SSP-violating counterparts (i.e., the /st/ clusters). Accordingly, it was argued that these idiosyncratic results follow from articulatory factors which make /st/ and /sn/ more marked (and thus more likely to induce epenthesis) than /sl/; that is, both /st/ and /sn/ sequences are considered more difficult to produce because their articulation entails a more effortful gesture from [+continuant] /s/ to [-continuant] /t/ or /n/. Finally, it was noted that whereas the observed sC learning hierarchy (sl > sn, st) had already been reported in L1 acquisition (e.g., Gierut, 1999; Grunwell, 1981; Ingram, 1989; Smit, 1993; Yavas & Beauburn, 2006; Yavas & Someillan, 2005), this hierarchy had not yet been documented in L2 acquisition research.

Less surprising were the results relating to the factor *preceding phonological environment*. These results, in general, lend further support to the cross-linguistic observation that preceding pauses and consonants behave similarly in a variety of phonological phenomena (Cardoso, 1999; Escartin, 2005; Winford, 1992). Finally, the results concerning L2 proficiency and style conform to those of several other studies of IL variation, especially with regard to the predictions of Major's (2001) Ontogeny Phylogeny Model. In particular, the results from the Farsi-English data have shown that over time (hence with increased L2 proficiency) and in more formal situations, the amount of L1 transfer (i.e., e-epenthesis) decreases, while the proportion of L2 features (sC onset cluster production) increases.

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